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Forest Sequences in the North Central State

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FOREST SEQUENCES IN THE NORTH CENTRAL STATES

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(WITH SIX FIGURES)

Introduction

This paper presents fifteen pollen profiles from as many peat deposits in Illinois, Indiana, Michigan, and Ohio, only two of which—Bucyrus and Mud Lake (Ohio)—have been previously published. These profiles have been prepared to show only the relative fluctuations of eight forest genera and one family, Betulaceae.

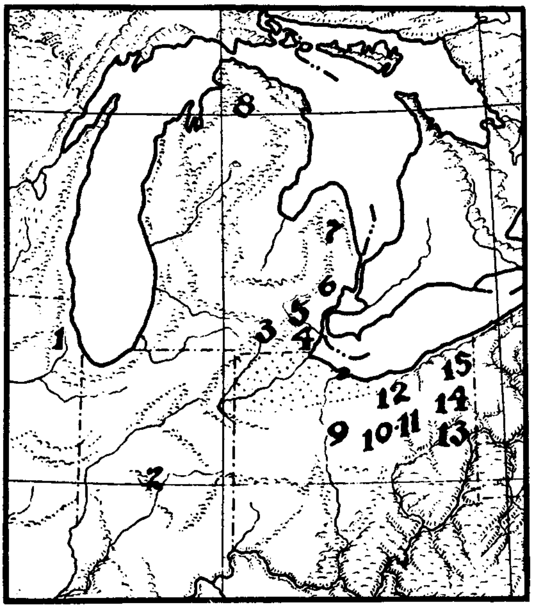

FIG. 1.—Location of bogs studied

The location of these deposits is indicated on the map (fig. 1) and again on each legend (figs. 2–6). Depth of samples analyzed is indicated by solid bars in each column, and by depth scale at the left. Length of bars represents relative percentages; but for more graphic comparison, bars are centered on scale instead of starting from zero point. In each graph, Roman numerals indicate corresponding stages.

A number of the profiles have been truncated by fire and cultivation. Others have been condensed because of drainage. Sedimentation began much earlier in some than in others, as is evident by noting positions relative to glacial retreat.

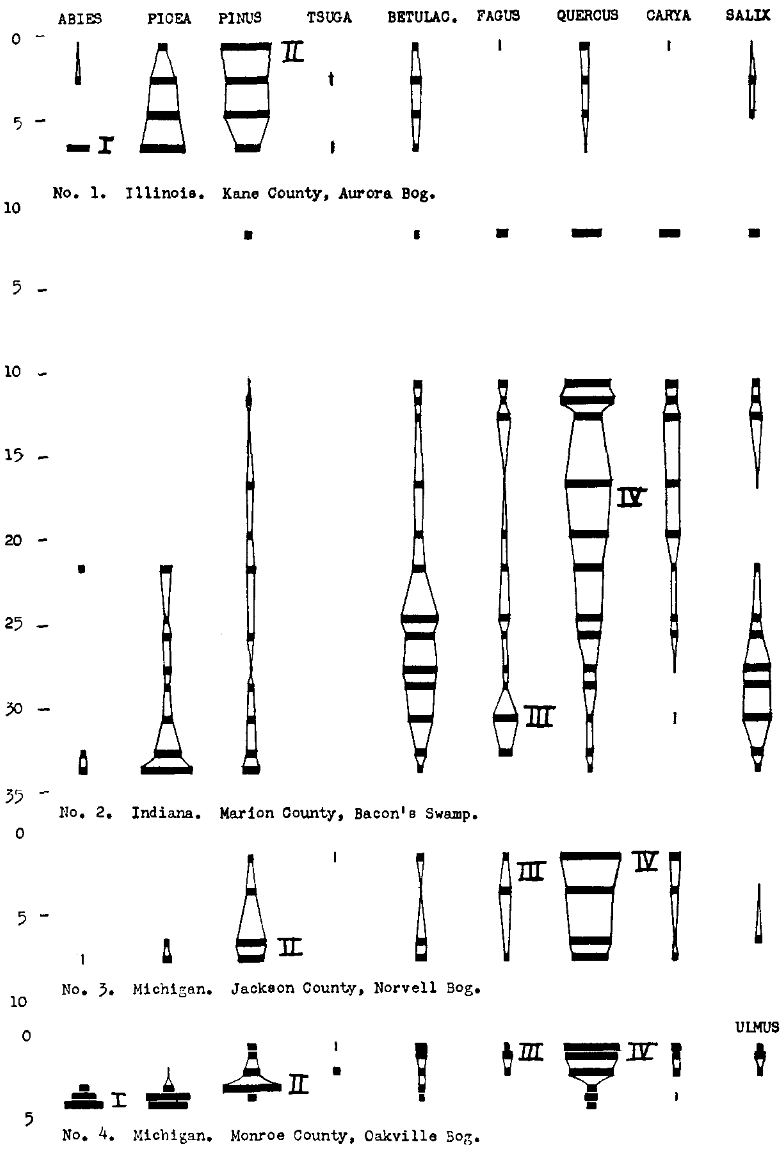

FIG. 2.—Pollen profiles of important forest components, bogs 1–4

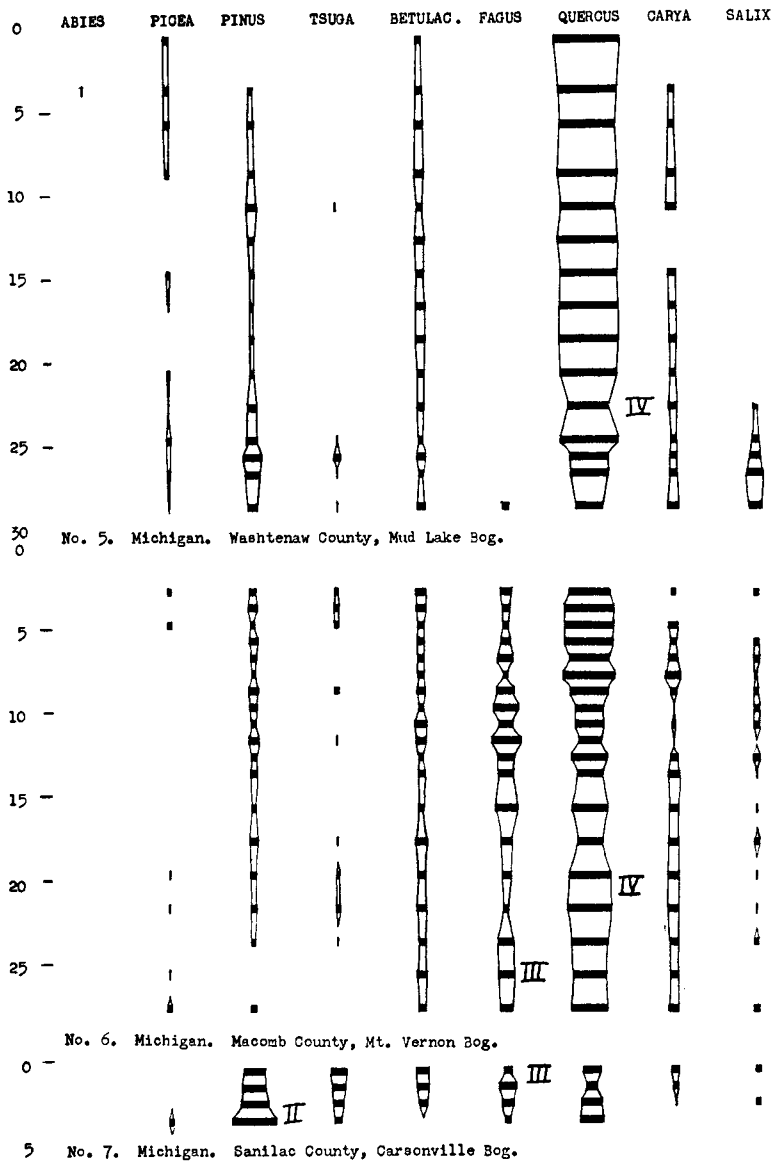

FIG. 3.—Pollen profiles of important forest components, bogs 5–7

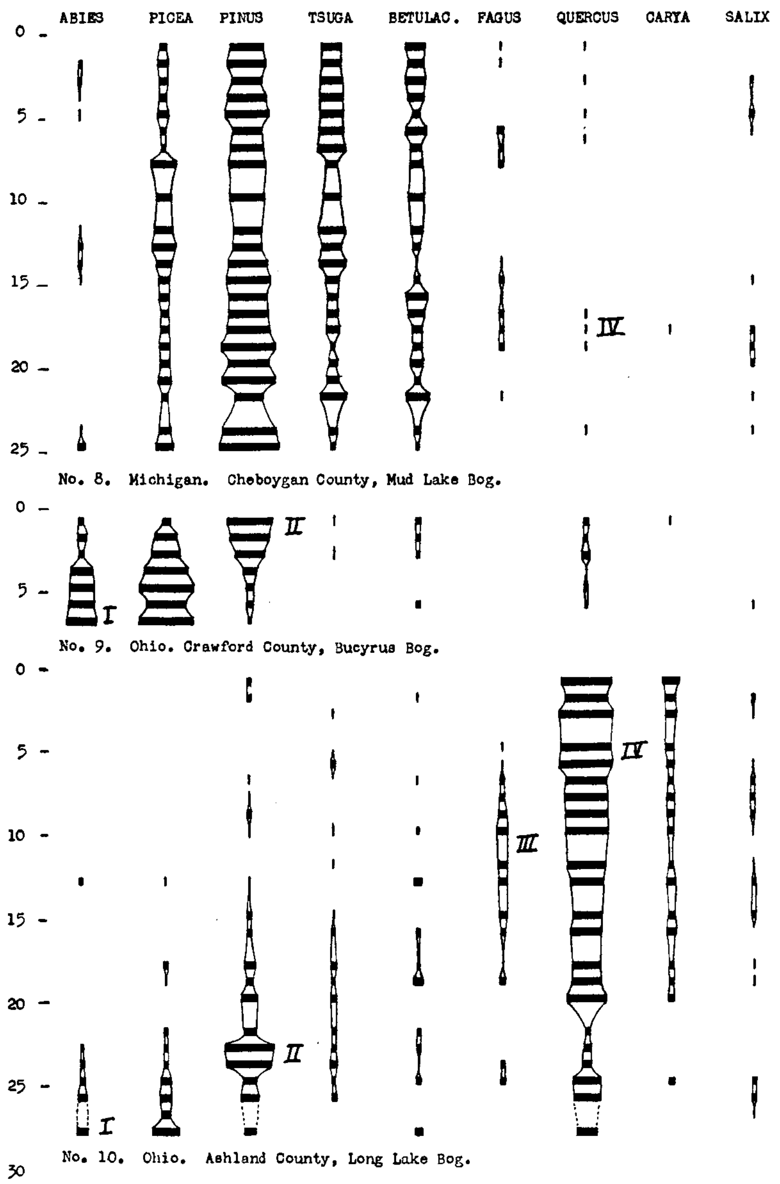

FIG. 4.—Pollen profiles of important forest components, bogs 8–10

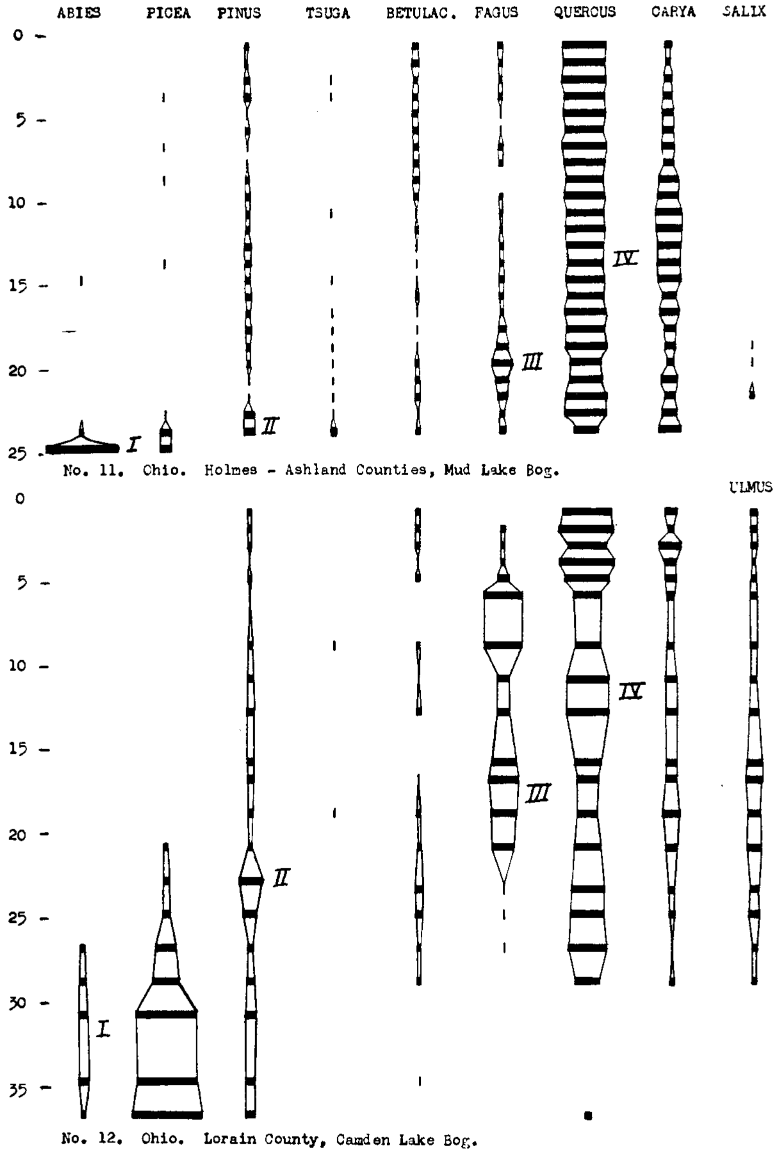

FIG. 5.—Pollen profiles of important forest components, bogs 11 and 12

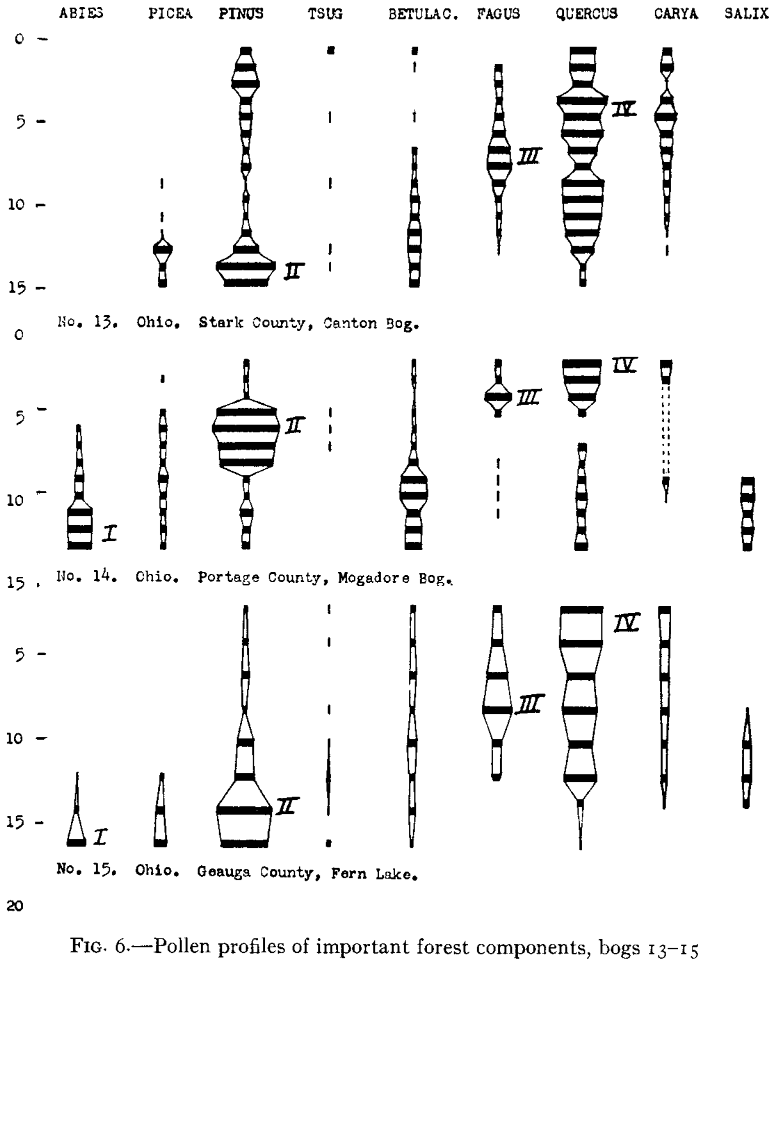

FIG. 6.—Pollen profiles of important forest components, bogs 13–15

Observations

1. Aurora Bog.—This profile was secured from material in which mastodon remains were found. It represents an early segment of postglacial time and shows a striking increase of pine at the expense of fir and spruce.

2. Bacon's Swamp.—This profile shows a brief maximum of beech following spruce and pine. Beech gives way to birch-oak, followed by oak-hickory.

3. Norvell Bog.—This profile shows pine reaching a maximum, then beech, followed by oak-hickory. The top of this deposit has been destroyed.

4. Oakville Bog.—This is an old deposit, truncated and condensed. The shift from fir and spruce to a sharp pine maximum is evident. The next shift, from pine to oak, is marked by a faint interval during which beech is at a maximum, although never abundant. Elm behaves like beech.

5. Mud Lake (Washtenaw) Bog.—This is essentially post-coniferous. The presence of beech and hemlock at the bottom, with oak minimum, probably corresponds to the end of early beech maximum noted elsewhere.

6. Mt. Vernon Bog.—This is likewise post-coniferous. Early and later beech shows maxima, inversely correlated with oak and hickory.

7. Carsonville Bog.—This condensed deposit has been severely burned and drained. It begins with pine and oak maxima, followed by a beech maximum which is temporary. Beech yields to oak and hickory; but pine, birch, and hemlock remain as important constituents.

8. Mud Lake (Cheboygan) Bog.—This corresponds to a deciduous period farther south. Spruce, pine, hemlock, and birch are found throughout. Temporary displacement of hickory, oak, and beech by spruce and hemlock is notable, near the middle of the profile. In position this corresponds to the second (upper) beech maximum shown in certain other profiles. It suggests cooling.

9. Bucyrus Bog.—This has been previously published (5). It shows in striking fashion the shift from fir and spruce to pine evident in the other early profiles of this report.

10. Long Lake Bog.—Here is a sharply marked pine maximum, following the waning of fir and spruce, and some distance above it a definite maximum of beech, replaced by oak and hickory toward the top.

11. Mud Lake (Ohio) Bog.—This has been previously published (6). At the base is a telescoped record of shift from fir and spruce to pine, oak, and hickory. Above this is a brief but striking maximum of beech, giving way to an equally striking but more prolonged dominance of oak and hickory. In the original report the waning of hickory near the top and the increase of other species, not here included, was interpreted as an increase of mesophytism in recent times. In view of

the other profiles here presented, however, it may be questioned whether this was justified.

12. CAMDEN LAKE BOG.—Here the pine maximum, marked by disappearance of fir and waning of spruce, is definite. Above it is the beech maximum, characteristic elsewhere and followed by a maximum of oak and hickory. Above this the cycle is again repeated, with a second beech maximum, followed once more by oak and hickory.

13. CANTON BOG.—This is very near the glacial limit. No fir is showing, but pine-oak maximum, followed in order by beech, oak, and hickory. The top of this deposit has been cultivated and doubtless also burned.

14. MOGADORE BOG.—The top is likewise destroyed, but the shift from fir to pine maximum is definite; likewise subsequent beech maximum, followed by oak and hickory.

15. FERN LAKE BOG.—Pine-oak maximum is very definite, with subsequent beech maximum, giving way to oak and hickory.

Discussion

Bog 8 lies in a region of coniferous forest. The remainder are in a region now characterized by deciduous forest—save no. 7, which is intermediate in position. Records of a formerly coniferous forest are present in all but nos. 5 and 6. In every instance this coniferous period was terminated by a strongly marked pine maximum. This is least marked in nos. 2 and 11. There is a concurrence of oak (often with hickory) and pine in nos. 3, 4, 7, 11, 12, 13, 15, and it is suggested in other profiles.

The pine maximum develops at the expense of fir in nos. 1, 4, 9, 10, 11, 12, 14, and 15; at the expense of spruce in nos. 1, 3, 4, 9, 10, 11, 12, and 15. The conclusion seems warranted that fir and spruce forests were replaced by pine. Spruce appears to bridge the transition from fir to pine. Generally speaking, this suggests a lowering of the degree of mesophytism. The usual order of succession is from pine to fir and spruce. This interpretation is strengthened by two circumstances: (*a*) the concurrence of pine and oak noted in the preceding paragraph and (*b*) the fact that the first pines to be represented are *Pinus banksiana* and *P. resinosa*. *P. strobus*, the most mesophytic, is most abundant toward the end of the pine maximum in the profiles studied. This is not shown in the diagrams.

Following the pine there is an increase of beech in nos. 2, 3, 4, 6, 7, 10, 11, 12, 13, 14, and 15. No. 1 shows the first appearance of beech at the pine maximum, but the record is truncated above that level. No. 5 begins above the pine maximum, and the only beech in the profile is at the base. No. 8 is not comparable, being in the coniferous region, while no. 9 has no beech and is truncated below the level at which beech probably first appeared. In every instance except these four, the beech increases to a maximum, then decreases in favor of oak and hickory. The behavior of beech suggests an increase of mesophytism, followed by a lessening similar to that involved in the shift from fir and spruce to pine.

Profiles 2, 6, and 12 show a second maximum of beech above the first. But at the top, all profiles extending through deciduous time (nos. 2, 5, 6, 10, 11, 12, and 13) agree in showing a dominance of oak and hickory over beech. So far as beech indicates mesophytism, the present or recent past is a time of reduced mesophytism. Here again no. 8 is regarded as anomalous, being in a different environment.

COWLES (**3**) employed the term retrogression to designate a lowering of the level of mesophytism in a community. While chiefly concerned with this phenomenon in relation to physiographic change, he pointed out that it may be due to other factors and specifically mentions climatic change as one. The normal course of succession he recognized as being toward the greatest degree of mesophytism possible under existing conditions. Other terms applied to this phenomenon are regression, rejuvenation, and degeneration. The term employed by COWLES has the advantage of priority and clarity of definition. For this reason, although the writer is familiar with criticisms of the concept (**2**), he agrees with CAIN (**1**) in accepting the term.

The preceding discussion may therefore be summarized in the statement that twice during postglacial times there has occurred a retrogression in forest composition in the north central states. The first was a shift from fir through spruce to pine; the second a shift from beech to oak and hickory. Three of the seven profiles which extend to the present show a second appearance of beech followed by a third retrogression. Whether this third retrogression was due to local causes, or to general causes whose operation was buffered in four of the seven profiles which extend through deciduous time, is not clear.

In the observed course of plant succession, the movement is from less to more mesophytism. Relative stability is reached when the mesophytes present are able to reproduce themselves under conditions of their own domination. It follows that, if vegetation is replaced by that which is less mesophytic, a disturbance of the normal course of succession has taken place. Such a disturbance is implied in the two rather general instances of retrogression just described. Three obvious factors are involved in such a change. These are space, light, and moisture balance. Unless new areas are being opened up to vegetation in the vicinity, a pollen profile that shows a shifting vegetation must indicate that the new kind or kinds of vegetation are using the physical space occupied by the old.

In general, the scale of increasing mesophytism is paralleled by an increasing shade tolerance, or a decreasing light requirement. So far as this is true, the possibility of retrogression would appear to be limited so long as the mature dominant mesophytes remain alive and in place, whether they are reproducing or not.

Both of these circumstances suggest strongly that retrogression from spruce and fir to pine, and later from beech to oak and hickory, must have been subsequent to the dying out, or killing out, of the more mesophytic forms.

It is not easy to postulate any biotic process or physiographic change so general in character as to account for such destruction and subsequent retrogression in the numerous localities involved. On the other hand, a less favorable water balance might produce just this result. Beech is notably sensitive to drought. Apparently the most reasonable explanation of the observed retrogression lies along this line.

The postglacial history of the Great Lakes is well known and has been marked by lowering of the drainage level. Conceivably this might have resulted in periods of rather general lowering of the water table. In view, however, of the variety of secondary drainage basins involved, the general low relief of the region, its generally adequate soil moisture before settlement, and particularly the continuous sedimentation within the basins studied, it may be doubted whether such recession of lake level would explain the retrogressions. On the other hand, these would be satisfactorily explained by periods of reduced humidity. This explanation is consistent with the presence of relict communities indicating one or more periods of relative dryness in postglacial times (4). And it agrees with the interpretation of Mud Lake (Ohio) profile (6). In this paper the writer classified the plants whose pollen was found on the basis of their supposed climatic significance. The conclusion was reached that there had been two periods of relative dryness, corresponding to those inferred from the present account of retrogressions.

In another paper (7) the writer compared the types of pollen profiles from various parts of eastern North America. With the exception of no. 8, those discussed in the present paper represent the "deciduous forest, central type" of the earlier report.

On the whole, the bogs of this region show little evidence of recent "climatic deterioration" in the sense of cooling and increased humidity following a postglacial warm, dry, or xerothermic period. The evidence of this is much clearer in the coniferous region bogs extending from Minnesota toward the Atlantic, where a maximum of oak is evident about mid-profile. This xerothermic oak maximum may correspond to the 18-foot level of our present no. 8 in northern Michigan.

The presence of "relict" species and communities, notably prairie, in the central deciduous area was responsible for the original hypothesis of a xerothermic period in North America. There has been no reason to assume that these western relicts were expanding aggressively at the time of European settlement. There is evidence to the contrary (4). So far as it has been studied, the general trend of plant succession in this region is normal—toward increased mesophytism. This may have been accelerated by the cooling and increasing humidity evident farther north. Or it may merely represent ecological recovery following the shock of the second retrogression evident in the present data. In neither case does it appear to have produced any striking effect in the profiles here considered. More detailed study of profiles which are intact down to the present may shed light on this problem. Meanwhile, the two periods of forest retrogression described appear adequate to explain the presence in the central deciduous region of species and communities of more continental type than is now prevalent there.

Summary

1. Fifteen pollen profiles from bogs in the states of Illinois, Indiana, Michigan, and Ohio are figured, thirteen of which have not before been published. All but one are in the central deciduous region.

2. The forest sequence in these profiles shows two periods of retrogression. The earlier was a retrogression from fir and spruce to pine. This was followed by a relative increase of beech, ending in a second retrogression, when oak and hickory increased at the expense of beech. Three of the profiles show subsequent increase and retrogression of beech, but this does not appear to have been general.

3. The two general periods of retrogression are assumed to have been due to climatic causes, producing a less favorable water balance. This is considered adequate to explain the presence of xerothermic relicts in the central deciduous region.

The analysis of Fern Lake Bog by EVA GERSBACHER and of Camden Lake Bog by PRESTON SMITH were thesis problems. Much of the field and laboratory work was made possible by grants-in-aid from the Carnegie Institution of Washington.

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LITERATURE CITED

1. CAIN, S. A., The climax and its complexities. Amer. Mid. Nat. **21**:146–181. 1939.
2. CLEMENTS, F. E., Plant succession. Carnegie Inst. Washington. 1916.
3. COWLES, H. C., The physiographic ecology of Chicago and vicinity: A study of the origin, development and classification of plant societies. BOT. GAZ. **31**:73–108; 145–182. 1901.
4. GLEASON, H. A., The vegetational history of the middle west. Ann. Assoc. Amer. Geog. **12**:39–85. 1923.
5. SEARS, P. B., A record of post-glacial climate in northern Ohio. Ohio Jour. Sci. **30**:205–217. 1930.
6. ———, Pollen analysis of Mud Lake Bog in Ohio. Ecology **12**:650–655. 1931.
7. ———, Types of North American pollen profiles. Ecology **16**:488–499. 1935.